



Weather and Space Weather Impacts for Users of GPS Radio Occultation

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August 14, 2012*





Overview



- Why GPS?
- GPSRO Benefits
 - Numerical Weather Prediction (NWP)
 - Space Weather Monitoring and Prediction
 - Impacts of signal in adjacent bands
- Summary





Why GPSRO?

- Assumption – Familiar w/GPSRO Method
- Two Applications/Areas of Impact
 - Numerical Weather Prediction
 - Space Weather Monitoring and Prediction
- Both Benefit from Key GPS Characteristics
 - Precision and stability of signal
 - Low-bias for accurate products
 - System resilience
 - Multiple sources and receivers



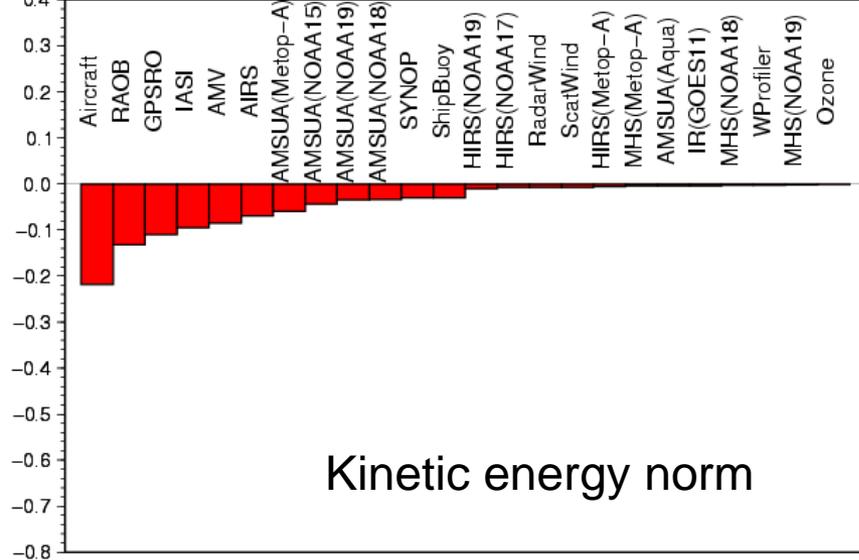


GPSRO Benefits



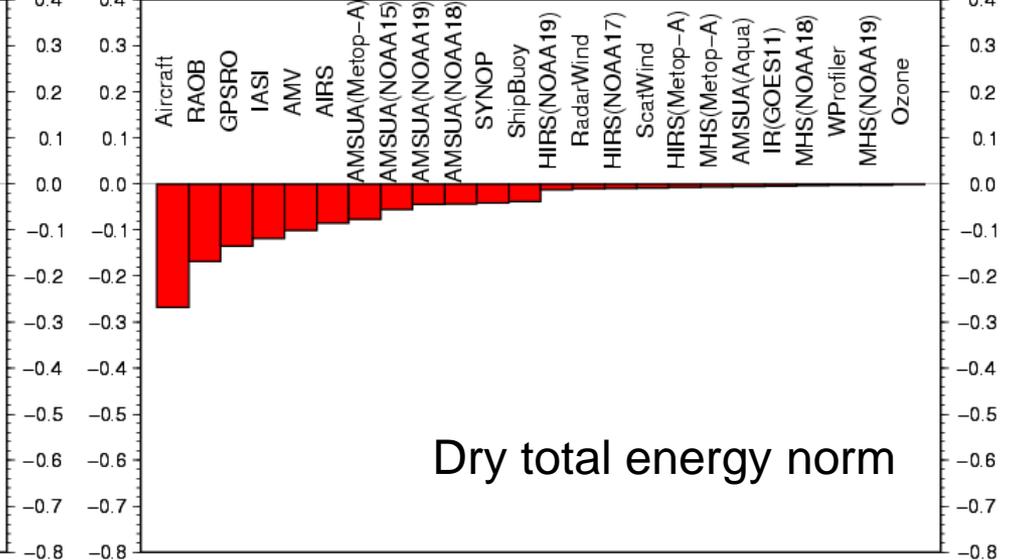
NWP Observation impacts with various norms

Total observation impacts in 1 cycle [kinetic energy, J/kg]



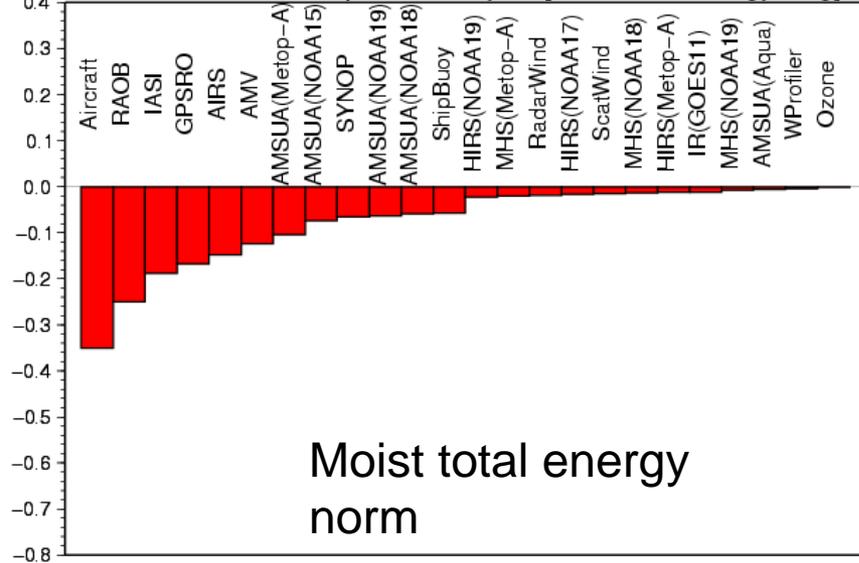
Kinetic energy norm

Total observation impacts in 1 cycle [dry total energy, J/kg]



Dry total energy norm

Total observation impacts in 1 cycle [moist total energy, J/kg]



Moist total energy norm

Accuracy, low-bias, and high vertical resolution of GPSRO soundings render them among the largest contributors to NWP forecast skill; GPSRO data complement and constrain other operational satellite sounders (both microwave and infrared); All-weather global distribution.

Serial EnSRF

GPSRO for Space Weather

Space weather (ionosphere) imposes the largest errors and service interruptions for many GPS users as well as loss of HF communication

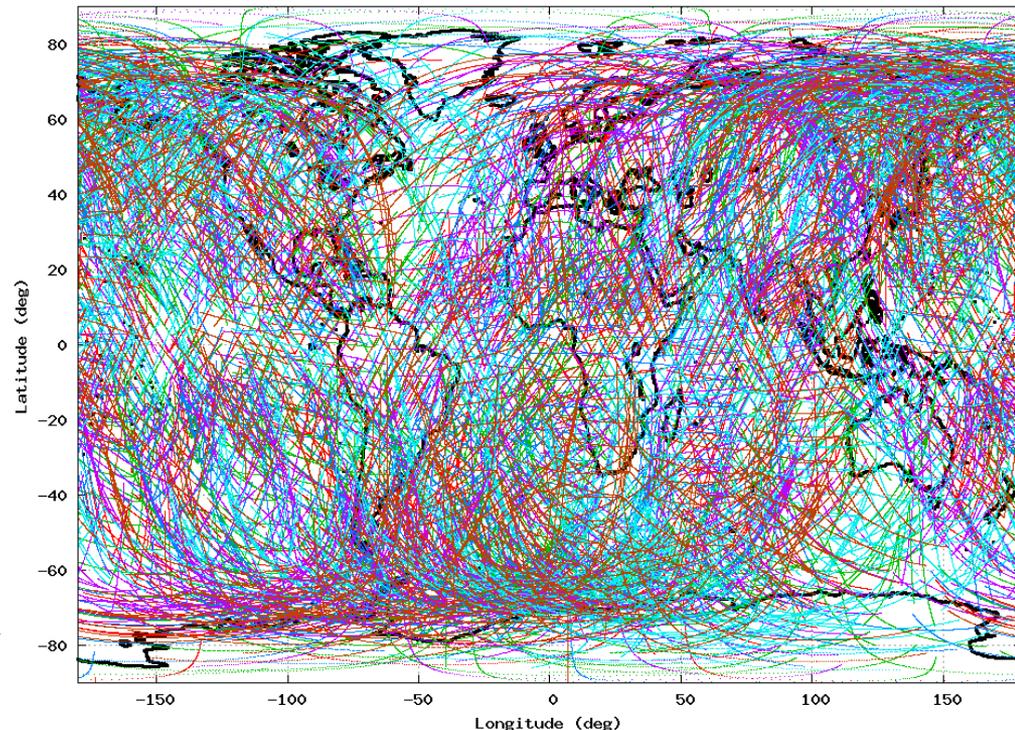
- Industries impacted by ionospheric storms:
 - Airline navigation and communication
 - Agriculture and construction
 - Surveying, drilling, and mining
- System Vulnerabilities
 - FAA's Wide Area Augmentation System procedures can become unavailable during space weather storms
 - Precise Point Positioning (PPP) impacted
 - Scintillation can result in denial of service for any application – L1/L2/L5
 - HF communication can be degraded or lost anywhere on the globe



GPSRO for Space Weather (cont'd)

Radio Occultation is the only technique to obtain uniform, global ionospheric measurements needed for space weather services

COSMIC Measurements in 12 Hours



- Uniform global coverage over oceans and land
- Accurate measurement of vertical ionospheric profile
- Critical input to data-assimilation models of the coupled ionosphere-atmosphere system
- Forecasts and alerts of ionospheric disturbances support growing Positioning, Navigation, Timing, and Communication applications



Impacts



- Use of adjacent bands is expected to degrade GPSRO:
- Reduced SNR in certain geographic areas
 - Increase random noise introducing refractivity errors;
 - Decrease further the number of occultations reaching the surface; lose water vapor info
 - Mitigation by use of more restrictive filters likely to introduce systematic errors





Summary

- NWS and other operational users rely heavily on GPSRO
 - For NWP, Space Wx Monitoring/Prediction
- Use of adjacent bands likely to degrade RO
- Loss/degradation of GPSRO would be detrimental
 - Would hinder our ability to help protect lives, property, and economic activity

